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Pneumonia Research and the Omics Revolution: It is Time for PneumOmics

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The traditional methodology of answering a research question has been to reach a deeper understanding of a particular biological process. By having a deeper understanding of the biological process, we will be able to reach a more comprehensive answer to the initial question. As an example, if we are interested in evaluating the host inflammatory response during pneumonia, we may start with the determination of blood cytokines levels. If a particular cytokine is significantly elevated, we may look at this cytokine at a cellular level to define the biology of the cytokine. We may look at the membrane-to-nucleus signal transduction to understand how the pneumococcus activates the production of the cytokine. Going deeper into cytokine biology, we may further study the regulation of gene expression of the particular cytokine. With this research approach, we aim to breakdown an initial complex interaction into their basic components in order to study these components individually. By studying the parts, we will gain a full understanding of the whole system.

This approach, attempting to answer the research question by looking at smaller and smaller entities, is defined as the "Reductionist Paradigm". The majority of researchers working in the field of pneumonia have been trained under this reductionistic science model.

It has been suggested that this reductionist approach may not be optimal when the research question is focus on a biological process that is too complex. In a complicated system, studying their parts may not allow us to understand the whole system, since the system may be operating beyond the sum of the parts. Using the example of trying to understand the inflammatory response in pneumonia, the system may reach a level of complexity that grasping a full understanding of the biology of particular cytokines may not be enough to explain the host inflammatory response.

In recent years a new research approach has emerged that is defined as the "System Biology Paradigm"^{1,2}. Under this approach, we do not look at each component at a time but on the contrary, we look at multiple components working together simultaneously. Instead of going deeper into the process, we look at the whole system and study the interaction of all components.

The system biology approach can be implemented due to the advances in different fields of biology ending with the suffix omics, such as genomics, epigenomics, transcriptomics, proteomics, and metabolomics. In microbiology we can now define site-specific microbiome profiles or microbiomics. These advances have been coined the "omics revolution".

Using the system biology approach, an investigator looking into the inflammatory response of patients with pneumonia will develop a wide model of host-pathogen interactions. Using an integrative approach to the biology of inflammation, the goal would be to understand how such complex molecular networks work.

As investigators, we may wonder whether to choose a reductionist approach or a system biology approach in tackling our research questions. First we must recognize that these two approaches are not in conflict with one another, but rather that the combination of these methodologies can be synergistic^{3,4}. Moving forward, we will need to be open to both approaches. As investigators, it will be important to have an understanding of the benefits and limitations of each approach. Depending on the research question, the best pathway may be a reductionist approach, a system biology approach, or a combination of the two.

Going back to our example, the key to understand the inflammatory response in patients with pneumonia may be to utilize a combination of a reductionist and a system biology approach. Utilizing this combined approach, we may be able to comprehend inflammatory response at a personal level, and use this knowledge to modulate inflammatory response and improve outcomes. In summary, we need to start combining our traditional pneumonia research with the omics revolution. It is time for PneumOmics.

References

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